The official voice of the Air Force Research Laboratory
news@afrl
Features
September 2003

Advances in high-temperature composites leads to bleed air duct cover solution

by Timothy R. Anderl, Materials and Manufacturing Directorate

WRIGHT-PATTERSON AIR FORCE BASE, Ohio — Materials research scientists and engineers from the Air Force Research Laboratory's Materials and Manufacturing Directorate designed and prototyped a new polyimide cover for B-1B bleed air ducts. The ducts connect the aircraft's engine bleed air to a heat exchanger, and the cover is critical to keeping volatile fluids from reaching a duct's hot surface, a situation that could prove catastrophic to flight operations.

Ogden Air Logistics Center, Hill Air Force Base, began manufacturing and producing the air duct covers at their high-temperature capable production facility in January 2003. The B-1B System Program Office (SPO) plans to place the parts on the aircraft on-site as they are delivered, so the project could be complete by July 2004.

"Breakthroughs in high-temperature polymer matrix composites, and a legacy of applying advanced composite technology to solve aircraft structural and service life challenges, allowed (researchers in the directorate's Advanced Composite Office, Hill Air Force Base, Utah, and Structural Materials Branch, Wright-Patterson Air Force Base, Ohio) to quickly design an air duct cover to replace the older cover, which was degrading in the B-1B's high-temperature environment," said Dr. Katie E. Thorp, a scientist from the Structural Materials Branch.

The basic construction of a B-1B bleed air duct includes a metal duct structure, which is surrounded by a layer of insulation. Surrounding the insulation layer is a polymer composite shell made with a polyimide resin. Air flowing through the ducts regularly reaches temperatures between 800 and 1,200 degrees F. "The shell is essential to safe operation of the aircraft because it keeps volatile fluids separated from the duct's hot surface," said Lawrence L. Coulter, chief of the Air Force Advanced Composites Office.

According to Coulter, engineers from the B-1B SPO at Tinker Air Force Base, Okla., first contacted ACO in August 2003 after they noticed that resin in the cover was deteriorating. This caused a problem for aircraft maintainers because there was no repair procedure for the polyimide cover and they were forced to condemn and replace any duct in this poor condition. In each of the B-1B's four engines there are two bleed air ducts, so replacing degraded air ducts quickly became a very costly problem.

After consulting with colleagues from the directorate's Nonmetallic Materials Division, engineers at the ACO, suggested that Air Force resin (AFR-PE-4) had material characteristics that qualified it as a candidate replacement for the degrading polyimide material, Coulter said. AFR-PE-4, another polyimide class material, is light weight and has thermal oxidative stability, which keeps it from degrading at the elevated temperatures it will encounter in this application.

Frank A. Bruce, an engineer from ACO, traveled to the directorate's Wright-Patterson Air Force Base, location to receive technical guidance, and hands-on experience with the AFRPE-4 material and its processing techniques. Using specific technical data gathered during collaboration with the Nonmetallic Materials Division, ACO experts designed a new duct cover, which was completed in November 2001. In addition, an ACO engineer met with maintainers on the flightline to discuss application of the new duct cover, and scale up and transfer to the production facility at Ogden Air Logistic Center was completed in November 2002, he added.

The B-1B SPO authored instructions, which were reviewed by engineers at ACO. The instructions will enable Air Force maintainers to apply the new covers as a field level repair during the B-1B's regular maintenance intervals. The Air Force currently has 60 B-1B aircraft in its fleet. @